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MANUFACTURE AND UTILIZATION OF HICKORY, 1911.

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CONTENTS.

	Page.
Introduction	3
Sources of supply	3
Uses of hickory	4
Lumbering and milling	9
Damage by insects	12
Marketing hickory	13
Recommendations	16

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INTRODUCTION.

In 1910 the Forest Service published the results of an investigation of the commercial hickories in the United States. Although this investigation was largely silvical in character, it included, to a certain extent, studies of hickory manufacture and utilization. In the course of the study certain conditions were found which it was thought could be investigated further with profit to the industries using hickory. Therefore the Forest Service, in cooperation with the National Hickory Association, has now carried out an investigation to ascertain the present methods employed in the manufacture, marketing, and utilization of hickory with a view to suggesting improvements. Over 4,000 hickory manufacturers and users responded to requests for information. The work was begun in the summer of 1910 and was finished in the spring of 1911.

SOURCES OF SUPPLY.

Hickory in commercial quantity was once found in every State east and in several States west of the Mississippi River. It reached its best development and was found in greatest abundance in the Ohio and lower Mississippi Valleys. At present it is listed in the lumber cut of 34 States. This is evidence that its range is as wide as ever and that it has maintained a foothold in spite of two or three centuries of use and abuse.

It should not be supposed, however, that its quantity is what it once was. Hickory and black walnut were said to constitute one-fourth of the original forests of tidewater Virginia. Many other large areas which once furnished much hickory now supply litttle. This is especially true of States north of the Potomac River, and is generally true north of the Ohio River also. Several other regions have passed their maximum production, and only fragments of the original stands remain. Most of what yet remains is found in the lower Mississippi Valley. No foreign country, except a little of southern Canada, yields hickory, and no foreign country is successfully planting or growing it.

Hickory is often spoken of as though it were a single species, like yellow poplar or beech, yet there are 10 species. There is marked

difference between some of them in both appearance and properties. All of the hickories are not found in the same region, but frequently several species grow near together. Arkansas has as many as any State, and there, too, is the present center of production.

From the forester's point of view the tree possesses some striking advantages. Birds and small quadrupeds plant the nuts, and the young trees put up a strenuous fight for existence. If during a young hickory's first years the part above ground is destroyed, the root sends up a sprout to repair the damage. It may do this repeatedly after fires or other enemies have destroyed the top. The vigor with which it sprouts and the habit of birds and small mammals of planting the seeds have made it possible for hickory to hold its ground over so wide a region.

Hickory does not and never did form pure forests of great extent. The trees are scattered among other timber. This holds for unculled forests as well as for those partly cut. Where an average stand of from 200 to 400 feet of hickory per acre is found upon tracts of considerable size it is fully up to the lumbermen's expectation. It is important that the manner of its growth be borne in mind, for several other factors of its yield are influenced by this. Hickory neither grows like many other commercial timbers nor can it be cut and marketed in the same manner. It is a peculiar wood in several respects—in growth, properties, uses, and marketing.

USES OF HICKORY.

Its combination of strength, toughness, and elasticity has made hickory the world's foremost wood for certain purposes. It offers supreme resistance to strains, twists, and shocks. The superior place held in many countries by the American ax is due as much to the hickory handle as to the steel in the bit. The same may be said of American hammers. The enviable reputation of harvest machinery made in the United States has placed it in every important grain-producing region of the world, and to the use of hickory is due much of its success. Other woods are satisfactory for heavy vehicles where strength is the chief requisite, but for light, graceful, handsome, springy buggies, carriages, and traps hickory is unequaled. It goes into wheels, poles, shafts, spring bars, and other straight and bent parts. The lightness and resiliency of the American racing sulkies have won universal admiration, and their superiority is due to hickory. The severe thrust, strain, twist, and compression which automobile wheels must sustain demand spokes of absolutely the best material obtainable, and for this the manufacturer is dependent on hickory.

Exacting demands are made upon this wood from other quarters. With the possible exception of ash, no satisfactory substitute for it has been found for sucker rods used in pumping oil wells. These rods

must be clear and straight pieces from 18 to 35 feet in length, long strings of them being coupled end to end to reach the bottom of deep wells. Hickory will sustain nearly as much load on a longitudinal pull as a rod of iron of the same size, and it weighs less than half as much. Sucker-rod buyers demand the best parts of the choicest hickory. Skewer manufacturers are making some use of hard maple, beech, birch, basswood, and persimmon. Hickory, however, imparts the least taste, and will not break or splinter when thrust into the meat or candy. Ash and hard maple are used to some extent for picker sticks. The strength and toughness of hickory, however, places it first for this purpose.

At present the principal demand for hickory comes from vehicle manufacturers and handle makers, and the mill men largely depend upon this demand for their market.

Hickory, however, is put to many other uses. For some of these it is the best procurable wood, but for others it is no better than several woods which may be had as cheaply and in as great abundance. When good hickory is employed for purposes which might be supplied by cheaper and more abundant woods, it is said to be a "wrong use." A material suitable for highly specialized uses should not be wasted in common and ordinary places, but reserved for purposes which no other wood can fill so well.

Table 1 shows the extent to which hickory is rightly and wrongly used in States where it is now most abundant and in others where it is now scant. The table shows that more hickory goes into wrong uses in regions where it is cut in rather small quantities than in places of abundance. This is due principally to the difficulty in marketing it in small lots. Mill men who cut but little, and that little in mixture with other woods, can not take as much pains to find the best markets as the man can who has many grades and a large stock.

TABLE 1.—*Uses of hickory.*

States where hickory is now most abundant.	Right.		Wrong.		Doubtful.[1]		Part right, part doubtful or wrong.	
	Number of mills reporting.	Per cent.	Number of mills reporting.	Per cent.	Number of mills reporting.	Per cent.	Number of mills reporting.	Per cent.
Arkansas	50	74.6	.....	.....	9	13.4	8	12.0
Indiana	106	54.7	23	11.9	37	19.0	28	14.4
Kentucky	48	60.0	5	6.3	18	22.5	9	11.2
Missouri (southeast portion)	104	96.3	3	2.8	.....	.....	1	.9
Tennessee	39	60.0	3	4.7	15	23.0	8	12.3
Louisiana	16	66.7	1	4.2	5	20.8	2	8.3
Mississippi	22	78.6	1	3.6	5	17.8	.....	.....
	385	68.0	36	6.4	89	15.7	56	9.9

[1] "Doubtful" covers cases where the mills failed to state the use to which the lumber was put.

TABLE 1.—*Uses of hickory*—Continued.

States where hickory is now scant.	Right.		Wrong.		Doubtful.[1]		Part right, part doubtful or wrong.	
	Number of mills reporting.	Per cent.	Number of mills reporting.	Per cent.	Number of mills reporting.	Per cent.	Number of mills reporting.	Per cent.
Missouri (except southeast portion)	22	22.9	50	52.1	4	4.2	20	20.8
Connecticut	35	76.1	.....	.....	9	19.6	2	4.3
Georgia	2	28.6	1	14.3	3	42.8	1	14.3
Iowa	2	20.0	2	20.0	4	40.0	2	20.0
Michigan	10	76.9	.....	.....	3	23.1	.....	.....
North Carolina	44	89.8	1	2.0	3	6.2	1	2.0
Pennsylvania	51	37.5	34	25.0	24	17.6	27	19.9
Virginia	24	66.7	3	8.3	8	22.2	1	2.8
West Virginia	41	50.6	10	12.4	21	25.9	9	11.1
	231	48.7	101	21.3	79	16.7	63	13.3
Average total	616	59.2	137	13.2	168	16.2	119	11.4

[1] "Doubtful" covers cases where the mills failed to state the use to which the lumber was put.

A review of some of the past and present uses of hickory for purposes other than vehicles, handles, sucker rods, skewers, and parts of agricultural and textile machinery, which are and should be the chief uses, will show both economy and waste to a greater extent than will the history of any other wood. What at the present time would be folly and waste, however, was not necessarily so in the past. Hickory withes—sprouts from 2 to 5 years old, 3 to 10 feet long, and from one-fourth inch to an inch in diameter at the ground—have been cut in countless millions, and every one was a young hickory tree. They were once the common farm repair material for mending gates, fences, wagons, sleds, and machines. They tied everything from the broken fence panel to the fodder shock. Nails, rope, and wire have been substituted for withes in most farm repair work. The hoop-pole cutter was as great a destroyer. Every one of the untold millions of poles was a promising young tree, the straightest and smoothest to be found, and exactly the kind to grow into spoke stock and sucker rods, had it been spared. Hickory hoop poles sometimes sold as low as $1.50 a thousand—a thousand promising young hickories for $1.50, because no one had then learned that one mature tree could be worked into a thousand hoops equally as good.

Hoop-pole cutting of that kind is chiefly a thing of the past, and the withe is less frequently pressed into service; but hickory still has many questionable uses. Some of these are justifiable under the circumstances, and under the conditions which at present obtain in the industry, but others are wrong and need correction. If a tree is inherently defective, that is, worm-eaten, or if its wood is brashy, or very knotty, its use for barn siding is justifiable. In the same way, if a tract of hickory is inaccessible, even though relatively near a

market, or if it is fairly easy to get at, but far removed from the manufacturer, the use of the trees for purposes for which other woods are suitable should not be considered wasteful, provided, of course, that the other woods could not be secured as cheaply.

On the other hand, in some parts of Pennsylvania hickory goes into mines as posts, props, rails, cribs, and lagging. There are perhaps 50 kinds of forest trees in that region as good as hickory for mine timbers, many of them better, for hickory is not an enduring wood in damp places. In West Virginia, oil-well derricks are occasionally made, in part, of this wood; while in parts of Missouri and in other regions, where it happens to be convenient, it is taken for bridges, barn floors, and doors, fences, sheathing, piling, culverts, crossties, car stock, and for other similar purposes. Such uses are included under "wrong" in Table 1.

In most instances these uses are unnecessary and wasteful. They are brought about, however, by present methods of cutting and marketing the stock. The farmer owns the hickory timber and, on account of the scarcity of other wood, is forced to use it about the farm. The sawing is done by mill men, who move from place to place, and use the engine that runs the farmer's thresher, corn shredder, clover huller, or ditching machine. The sawyer is paid by the thousand feet, and in his effort to turn out the greatest possible quantity of lumber, carelessly cuts a larger percentage of low-grade stock than necessary. Such practice is on a par with a custom, once rather common, of splitting black walnut for fence rails. The difference is that the owners of black walnut know better now, while some hickory owners have the lesson yet to learn. An expert sawyer could probably make it more profitable for the hickory owner to sell to the vehicle or handle factory and buy other woods for his building purposes. The use of hickory for certain products in place of inferior wood would be greatly reduced by operating the central distributing yard discussed under "Lumbering and Milling" in this report.

Statistics collected during this investigation show that 31,000 cords, or approximately 22,000,000 feet, of hickory are yearly demanded by the 473 meat-packing establishments in the United States for smoking meat. That does not include what farmers cut for their own smokehouses, which is probably as much more. More than 25 different woods are listed as suitable for smoking meat, yet all of them together do not equal the amount of hickory. (See Table 2.) Nearly all reports state that hickory is more satisfactory than any other wood for this purpose. It emits a maximum of smoke with no increase of heat; it imparts a pleasant flavor; it gives the meat a bright, clear, yellow color that is uniform over the entire surface; it burns slowly and thus cures the meat thoroughly; and it

smokes the meat with a minimum amount of shrinkage. In order to satisfy the United States regulations restricting the amount of shrinkage, many packers sprinkle their wood with sawdust from mahogany, walnut, cedar, and other hard and soft woods. The sawdust increases the amount of smoke with no increase in shrinkage, and at the same time prevents particles from rising and injuring the taste and color of the meats.

TABLE 2.—*Woods used for smoking meats.*

Species.	Cords.	Species.	Cords.
Hickory:		Gum	6
Split wood (28,008 cords)	31,207	Maple	8,655
Poles (2,560 cords)		Mountain mahogany	36
Miscellaneous (639 cords)		Miscellaneous woods	944
Apple	12	Oak (miscellaneous species)	6,809
Ash	154	Oregon oak	342
Aspen	50	Pecan	85
Beech	1,417	Poplar (Utah)	40
Birch	8	Sycamore	13
California live oak	50	Utah white oak	10
California white oak	1,361	Walnut	24
Chestnut	233	Western alder	792
Chestnut oak	15	White oak	85
Cottonwood	745	Yellow pine	59
Elm	200	Total (woods other than hickory)	22,155
Fruit trees	10	Total (all woods)	53,362

The packers prefer split cordwood, in 4-foot lengths, and seasoned from three months to three years. Tops and limbs are seldom accepted, although round pieces down to 2 inches in diameter can be used. Table 2 shows that of the 31,207 cords of hickory used 28,008 cords were in the form of regular split wood from 1 to 4 feet in length; 2,560 cords were in the form of poles; and 639 cords were in miscellaneous sizes and forms, such as limbs, tops, slabs, scraps from shops, and waste from vehicle manufacturers.

It seems unreasonable to expect packers located near the hickory supply to substitute inferior woods. A wider use of pecan and of hickory waste from the factory and the woods, however, is strongly urged. A number of packers are now using this material as part of their supply. Its more general utilization would save an appreciable amount of the better material needed by the manufacturers of vehicles, handles, and other special hickory products.

No one knows how much hickory is consumed for fuel. One estimate places the amount at 1,000,000 cords a year. That is probably too high. If not, it exceeds in quantity the combined demand for hickory for all other purposes. It is well known, however, that the cutting of this wood for fuel has long been a serious drain upon the supply. More than a century ago A. F. Michaux, a French traveler in this country, sounded a warning that if the cutting of

hoop poles continued and the felling of large hickories for fuel was to go on, the United States would be without hickory in 50 years. His prediction was not verified, but there was much ground for uttering the warning; and if the warning was timely then, it is timely still. Even if the output of cordwood for fuel is only one-half of what it has been estimated, it is a most serious drain upon the hickory supply. In many cases the cordwood cutter takes waste only, but too often the whole tree goes into the fuel rick.

LUMBERING AND MILLING.

More than 5,000 mills were cutting hickory lumber in the United States in 1908, as reported by the census, and the output approximated 200,000,000 feet. It is necessary to distinguish clearly between hickory lumber and other forms of the wood. Gear woods, rims, and many other commodities may or may not pass through a sawmill. If they do not, they are not listed by the census as lumber, and the 200,000,000 feet reported for 1908 did not, therefore, include all the hickory taken from the forests that year. How much it fell short is not known, but it lacked much of being all. A recent investigation found 131,000,000 feet in excess, or apparently in excess of what the census reported. This was cut by small dimension mills into strips, billets, and various forms of vehicle and other special stock. Some of the 200,000,000 feet reported by the census was subsequently further manufactured into special stock, and some went into floors, bridges, barns, fences, and other similar places. Much hickory is split into billets and never goes to a sawmill or dimension mill. Lathes and other machines finish the products.

Hickory is cut by sawmills and dimension mills of all kinds from comparatively large to very small. The sawmills cut the log into lumber, which later is often ripped into dimension stock. The dimension mills cut the log or bolt directly into pole, shaft, and rim strips, spoke billets, handle billets, and other rough dimension stock. Many of the mills are portable and operate on small bodies of timber or in communities where scattered trees may be brought to a single point in quantity sufficient to warrant the placing of a mill. A full account of hickory-mill practices would be too long for the purposes of this circular. Methods in one region may differ from those in another where entirely different conditions are met. In general, however, most of the hickory is cut by small dimension mills. It could not be otherwise where growth is scattered and timber scarce and where mills must frequently move from place to place in search of new stands. Some mills cut hickory exclusively; others handle it along with oak or other hardwoods. In some instances large sawmills log this timber as they come to it in their usual operations, but

they do not go out of their way to find it. Others prefer not to cut it at all, since they are not prepared to handle it conveniently. Such mills sometimes leave hickory on tracts of thousands of acres from which the other timber is cut. One of the important problems of the hickory situation at this time is the utilization of this remaining thin stand of hickory. Operators do not find it profitable to take it out along with their other timber. They move on, and their log roads go to pieces, their bridges rot down, and their skidways decay or are removed. The hickory is so scattered that the expense of making a special operation to take it out, involving the construction of new roads and bridges, would cut profits very low, or might even involve a loss. Fortunately, hickory is little susceptible to injury from wind after the surrounding protective timber is cut away, and it can wait a long time for its market. Nevertheless, it stands idle while many industries need it.

During this investigation a number of lumber companies which leave hickory in this way have been questioned to ascertain their interest in one or more propositions to sell the hickory to the special users and thus realize a profit on it. Three propositions were submitted to them, as follows:

(*a*) We could furnish —— feet per month for —— years to a dimension mill located at our sawmill, providing we could secure $—— for our hickory stumpage and make satisfactory arrangements for cutting the trees and hauling same to our cars.

(*b*) We could deliver the logs at our mill or at a dimension mill near us for $—— per 1,000 feet b. m., and we would look after the cutting and hauling; on this basis we could furnish —— feet per month for —— years.

(*c*) We could furnish —— cars of hickory logs or bolts per month to a hickory dimension mill located at a distance from our mill and could furnish the logs at $—— per cord f. o. b. our mill.

A few companies replied that their supply of hickory was too small for them to consider disposing of it in the way suggested. Other concerns, however, showed great interest in the proposition, one of them reporting 5,000 acres in one body which will cut over 2,000,000 feet of hickory. This company is building a logging road through its hickory land, and desired to get in touch with a hickory user by the plan outlined under (*a*) or (*b*). Another concern reported 15,000,000 feet on 150,000 acres, and stated it could supply a special user for 10 or 15 years by the terms of either (*a*), (*b*), or (*c*).

Most mills cutting hickory are equipped for special dimension stock—sucker rods, poles, shafts, handles, spokes, skewers, and parts of farm and textile machinery. One mill may not cut all, but several of the dimensions; others cut one or two. Each kind of mill strains a point to get out of a tree, or from a tract of hickory land, as much stock as possible for its particular purposes. This is known as spe-

cializing, and the practice has been criticized on the ground that trees capable of yielding long pieces of clear material are worked into short-length products—an uneconomic practice.

It has been popularly supposed that much waste accumulates about the special mills or in the woods where their logging operations are carried on; but this investigation did not find as much waste as had been reported. This is particularly true throughout the territory where hickory is now most abundant. In such localities the manufacturers of various hickory products have advanced their portable mills until they all operate quite close together. The farmer owning a tract of timber, therefore, meets representatives of two or more industries and sells to the highest bidder, all bidders meanwhile having estimated the timber for their special purposes. The millman making the longer-length products gets more money out of the tree and can afford to pay more for it. He, therefore, probably outbids his competitors, secures the tract, cuts for his purposes, and sells the remaining trees to the manufacturer of the shorter-length products. In the territory where hickory is now scarce or where the operators are more scattered and competition therefore less keen, however, the entire tract is more apt to be cut over by a single manufacturer, who leaves in the woods or wastes at the mill whole trees or parts of trees not useful for his particular purpose.

Unnecessarily high stumps are an important item of waste, since some of the best wood is near the ground. Data compiled during this investigation show that the millmen are improving their practices of a few years ago. Table 3 shows that 13 per cent of the mills reporting cut their stumps as low as 6 inches; 40 per cent cut to 12 inches; 32 per cent to 18 inches, and 15 per cent to 24 inches or over. Stump waste is greatest in open-grown, short-trunked hickories.

Trees left standing in a remote situation are not wholly waste. They serve as seed trees, and with the aid of wind, water, birds, and rodents, they may stock much open ground with seedlings for the country's future hickory supply.

Occasionally logs are cut several inches longer than necessary, and thus several inches must be thrown away. Another waste results from splitting stock instead of sawing it. Much wood is lost because of small defects which a saw would remove, but which can not be split out without sacrificing more or less good timber.

TABLE 3.—*Hickory dimension—Mill practices.*

	Number of mills reporting.	Per cent.
Saw gang paid:		
By day	311	66.9
By contract per M feet	154	33.1
Average height of stump:		
6 inches	48	13.3
12 inches	145	40.2
18 inches	113	31.3
24 inches and over	55	15.2
Logs transported to mill:		
By horses	320	40.1
By mules	232	29.1
By oxen	116	14.6
By tramways	30	3.8
By railroad	99	12.4
Log or bolt cut to increase output of sapwood	140	48.6
Log or bolt not cut to increase output of sapwood	148	51.4
After manufacture, product is piled under sheds	203	45.1
After manufacture, product is left exposed	247	54.9
Product is sold by established grades	225	77.6
Product is sold by mill run[1]	65	22.4
Product is shipped in solid car lots	123	44.6
Product is shipped in mixed car lots	153	55.4

[1] "Mill run" is clear stock, not separated into grades.

DAMAGE BY INSECTS.

More than 150 insects prey upon hickory, some on the green trees, some on logs after they are cut, and some on seasoned lumber or products.[1] Those which attack the living leaves, twigs, bark, and wood may be dismissed without special mention. They sometimes do considerable injury, but the amount is not easily estimated in terms of feet and dollars. When attack is made on logs in the woods, on skids, or in the yard waiting for the saw the damage is more visible and can be estimated. The wood is perforated with holes of considerable size, and nearly 8 per cent, on an average, is thus destroyed. The chief injury is done before the inner bark becomes dry. Loss may be lessened by keeping the logs off the ground, thereby hastening the drying of the bark; or if they can be kept under water the insects can not enter. Another way to lessen loss is to hurry the logs to the mill and convert them into lumber or other products before beetles have time to bore them.

When hickory passes through the mill and goes to the yard or shed and is seasoned it becomes subject to other injuries which may do more harm than was done while the logs were in the woods or the mill yard. Such injuries include damages by powder-post beetles, other wood-boring insects, and losses due to checking, warping, and staining. Statistics from a large number of mills show that 5.2 per cent of the manufactured product is spoiled by the powder-post

[1] For further information concerning insect attacks apply to the Bureau of Entomology, Department of Agriculture, Washington, D. C.

beetles, an additional 7.6 per cent by other wood-boring insects, and that 4.9 per cent is lost in seasoning.

The powder-post beetles are so called because they convert dry wood into fine powder. Their presence is detected by the appearance of the powder on or beneath the wood. The beetles are very small, and are not likely to be seen unless looked for very carefully. Large quantities of seasoned hickory, both finished and unfinished, are sometimes ruined by them. They operate most destructively in wood which has been seasoning a year or more. It is possible to lessen or prevent this loss, but vigilance and promptness are necessary. If a lot of wood becomes infested with powder-post beetles not much can be done to save it, but steps should be taken to prevent the spread of the beetles to other wood. Infested stock and near-by material which has not yet been attacked should be sprinkled with kerosene oil. Stock should not be kept on hand longer than necessary, because there is always some risk that beetles may get into it.[1]

MARKETING HICKORY.

Hickory is marketed unlike any other wood. The sawmills cut other hardwoods for a general market, through which it is distributed to the user. This general market studies the demands of the trade as a whole and calls on all mills cutting each kind of wood to furnish certain sizes and grades for which the trade is in need. Little hickory, on the other hand, goes through a market or distributing yard. It is chiefly cut for a special industry and sold directly to it. Each industry has its own mills in the hickory-producing territory and comes into direct contact with the millmen cutting its raw material.

The little hickory that gets to the wholesaler is chiefly cut 5/4 inch and thicker, suitable for remanufacture into the stock required by the vehicle man or other special user. The inch stock is cut only to square the log and to prevent heavy slabbing. Several hundred wholesale yards were investigated, and of these only two out of every five included hickory.

A considerable amount of wood is disposed of to exporters. This is true chiefly in the Gulf region. The practice has been complained of by manufacturers in this country who look with little favor upon the shipping of hickory to foreign countries when it is needed at home. While it is true that all the good hickory is needed by American manufacturers, the man who has it for sale will sell where the price is best; nor is it practicable or desirable that trade should be restrained by laying an embargo upon this wood. Sometimes the

[1] For further information on prevention of insect injuries to forest products see Circular 128 of the Bureau of Entomology, U. S. Department of Agriculture.

long haul to the factory with the high freight, and the short haul to the exporting point with the lower freight, control the direction which the shipment takes. If, however, the extra rigid inspection of export stock results in throwing out so much of it that the actual profit to the seller is not greater than if he had sold at home, the export of hickory will fall off, and the home factories will get what otherwise would have gone abroad.

A leading manufacturer of long and short length hickory products has in successful operation a plan by which chance and accident are largely dispensed with in cutting and marketing hickory, and waste is reduced to a minimum. The company is fortunate in owning or controlling a number of mills, and also a number of factories where the sawmill products are worked up. It is thus in a position to try out plans for controlling both supply and demand, so far as its mills and factories are concerned. A yard has been established at a convenient freight-breaking point between its southern dimension mills and its northern manufacturing plants, and all inspection is done at the yard. The mills ship their rough stock to that point. It is there carefully separated by sizes and grades, and is piled under cover. Since each mill sends all it saws, it can make frequent shipments without waiting to accumulate certain quantities of specified sizes and grades; and, since several mills are constantly forwarding their cut, the yard is kept supplied with all kinds of products.

The yard sees to it that all the factories are furnished with the sizes and grades needed. It is in a position to notify the mills when certain stocks are short and to order new supplies. By anticipating future wants the factories can have special orders filled against the time of need. In short, the yard is the central point from which the operation of the mills is directed, on the one hand, and the wants of the factories are looked after, on the other.

The successful operation of this plan by a single concern has suggested its adoption by an organization of all hickory factories. Most of the factories are in the North, but a number of them are South. Many northern factories have also established main stationary mills in the South which rough turn the stock sent in by the small portable mills and ship it to their northern factories to finish. The northern and southern factories and stationary main mills own or back a large number of the small portable mills making spoke and handle billets, rim strips, and other rough pieces. In many cases the small mills are independent, but on account of nearness to a particular factory or main mill are forced to sell their entire output to it. Comparatively few of the small mills sell to operators that compete for the output of these mills. Such competition, in fact, is limited to the narrow area in which hickory is now quite abundant. The direct

and indirect control of the small mills by the factories and the large number of the small mill operators eliminate the idea of organization among the small millmen, the producers. Such an organization, in order to be effective, must be among the factories, the consumers of the rough-turned product. This organization would regulate the economic cutting of stock only, leaving the amount produced and prices to be determined by natural demand and supply.

This plan at first thought may suggest a combination or trust which might become an instrument for limiting the output of hickory. Exactly the opposite is true. The present output is too limited, due to the natural conditions which have been described, and barely meets the needs of the consuming industries. The proposed plan aims solely at getting more useful material out of the present supply. It aims to reduce the waste in hickory to the lowest possible point, and to draw hickory out of those uses for which it is no better than a dozen more plentiful woods and attract it to those uses where it has no substitute.

More than one central yard would probably be needed to act as clearing houses for distributing all forms of products to the various hickory factories. Mills would be kept advised what products were needed at the factories. It is predicted that in a short time no mill would be cutting hickory into barn floor stuff, but would make it into sucker-rod or ax-handle stock. The members would be told how to cut trees in a way to get the most out of them, to saw logs most profitably, to prevent insect injury, to lessen loss by checking, what to do with short pieces, and all other information of value in a business way. The manufacturer's wants would be studied to the end that the hickory he buys may reach him exactly as he desires it. The clearing house would act as a bureau of education, and would push its labors in that field until good hickory ceased to go into wrong uses and every tree cut was worked for all it would make. Moreover, the proposed system would provide an established market and prevent the alternating feast and famine that unsettles the present hickory supply.

Prices, under such conditions, would regulate themselves. For example, if the supply of spokes were greater than the demand while there was a scarcity of handles the price of one would decline and that of the other advance. The mills, being kept constantly informed of the state of the market, would naturally cut down on the one commodity and increase the other. In short, the natural law would work out, but work more speedily and with less loss than where the facts governing the market are not promptly made known.

RECOMMENDATIONS.

As a result of the investigation it is recommended:

First. Improved cutting and marketing of stock now cut for "wrong uses," such as bridges, barn floors, grain doors, fences, piling, culverts, crossties, car stock, mine props, rails, cribs, and lagging.

Second. A wider use of pecan trees and of mill and factory waste for smoking meats.

Third. Better protection for green trees, logs, and seasoned products from insect enemies.

Fourth. A wider use of dimension mill waste for the manufacture of small products which must be of hickory. At the present time many mills and factories use the rejects of their larger products for the manufacture of smaller ones. The closer utilization of the offals for their own small products, or the shipment of such rejects to other concerns, is not now profitable because of the lack of proper machinery and the high cost of labor against the low cost of stumpage. For example, skewers range from 4½ inches in length and five thirty-seconds of an inch in diameter to 16 inches in length and three-eighths of an inch in diameter. The raw material for these products is hickory bolts in lengths of 5 feet and multiples of 5 feet. The manufacturers of the longer-length products point to this as needless waste and hold that their offals would supply a large part of the raw material needed for skewers. The skewer manufacturer, however, has proved that it is more profitable to buy bolts and logs that can easily be fed to the machines than to buy cheap reject stock that requires much labor in handling and sorting.

The value of hickory stumpage is now based on the value of the cleared land to the owner. A rise in the price of stumpage caused by basing its value properly on supply and demand will force the manufacturer of small products to buy material now wasted by the manufacturers of large products. It will also bring about the invention of machinery for working up the small pieces.

Fifth. That the hickory users take steps to secure the hickory left standing by the large pine and hardwood companies operating in the lower Mississippi Valley. This report has discussed the reasons which cause these concerns to leave their hickory stumpage uncut at the time they log the rest of their timber, and has submitted three propositions by which the hickory users may secure this additional material. The sale of this timber would be of mutual benefit to the pine and hardwood companies now getting no returns on it and to the hickory users who are in constant need of new supply.

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